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# PATENT ABSTRACTS OF JAPAN

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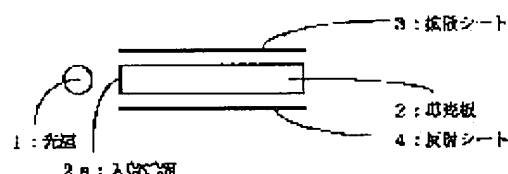
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## (54) LIGHT GUIDE PLATE

### (57)Abstract:

PROBLEM TO BE SOLVED: To prevent large warpage or deformation after a plate is formed, by controlling the stress on the surfaces of two principal planes facing each other to a specified value or smaller.

SOLUTION: In the light guide plate 2, the stress on the surface of two principal planes facing each other is specified to  $\leq 200$  kg/cm<sup>2</sup>. As for the means to control the stress on the surface of the light guide plate 2 to  $\leq 200$  kg/cm<sup>2</sup>, the following methods for the production are used. For example, the light transmission plate is produced by an injection molding method by low pressure molding to reduce the feeding pressure, the plate is produced by an injection compressive molding method, or the plate is produced by a normal injection molding method and then subjected to annealing treatment. The synthetic resin used for injection molding is not especially limited as far as it is a transparent thermoplastic resin, and for example, a polymethylmethacrylate, a polycarbonate, a polystyrene, a thermoplastic elastomer, or copolymers of these can be used.



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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the light guide plate of the lighting system used for the back light of a liquid crystal display etc.

[0002]

[Description of the Prior Art] The schematic diagram of the composition of a lighting system used for the back light of a liquid crystal display etc. is shown in drawing 1 . As shown in drawing 1 , in this lighting system, the light guide plate 2 arranged so that it may be located near the light source 1, the diffusion sheet 3 arranged on the front face of a light guide plate 2, and the diffusion sheet 3 of a light guide plate 2 consist of reflective sheets 4 with which the light sources 1, such as a cold cathode tube, and incidence end-face 2a have been arranged at the opposite side. In the lighting system of such composition, the light from the light source 1 carries out incidence into a light guide plate 2 from incidence end-face 2a, and while the light which carried out incidence is reflected in a light guide plate 2 in the field of the diffusion sheet 3 and the reflective sheet 4, incidence end-face 2a is transmitted in the opposite direction. A part of light comes out out of a light guide plate 2 between them than the front face of a light guide plate 2, it passes along the diffusion sheet 3, and the lighting light of uniform brightness is obtained by coming out to the exterior of a lighting system as the diffused light.

[0003] Conventionally, in the lighting system which has the above-mentioned composition, in order to acquire the uniform diffused light, patterns from which roughness and fineness changed according to distance with the light source, such as the shape of a dot, are printed, concavo-convex processing is carried out, crimp processing is carried out, or prism-like heights are prepared in the rear face (field by the side of the reflective sheet 4) of a light guide plate.

[0004] the case where a light guide plate is manufactured by the injection-molding method -- a dot-like non-dense, generally the pattern which has a dense distribution is processed using the metal mold with which the concavo-convex pattern contrary to a desired concavo-convex pattern was formed in the predetermined field There is a dwelling process in the injection-molding method of a light guide plate, and the configuration of metal mold is imprinted by adding a pressure in a cavity through a spool or the melting resin of a runner until injection restoration of the melting resin is carried out into the cavity of metal mold in a dwelling process and the gate section carries out cooling solidification. after the gate solidifies -- metal mold -- cooling solidification of the inner resin is carried out, and mold goods (light guide plate) are obtained

[0005]

[Problem(s) to be Solved by the Invention] If the melting resin by which injection restoration was carried out into the cavity by the injection-molding method touches a cavity side, while it will be cooled rapidly and a cooling solidification layer will be formed, it fills up with a melting resin in a cavity. At the time of restoration of a melting resin, pressure distribution occur in a cavity, and it serves as residual stress of mold goods, and causes generating, such as curvature after fabrication, and deformation. Moreover, although die shrinkage is added to dwelling in injection molding of a light guide plate at an amendment sake, mold goods are made to produce residual stress also by this.

[0006] In order to reduce generating of the cooling solidification layer used as the cause of producing residual stress, the correspondence of a process condition, such as making a die temperature high and making restoration speed high, which makes temperature of a melting resin high is considered. It curves, although it must avoid that residual stress which it curves [ residual stress ] in a light guide plate and generates deformation etc. remains in the light guide plate after injection molding, and if it is the residual stress of a grade which does not result in generating of deformation etc., even if it remains in the light guide plate after fabrication, it does not produce un-arranging. However, conventionally, the examination about the reference value of the residual stress which remains in the light guide plate after fabrication was

not made, but whenever it changed and fabricated the process condition, had to perform the reliability trial which attains to a long time, and had to determine the propriety of a process condition.

[0007] The light guide plate of this invention was made to solve the above-mentioned technical problem, and aims at offering the big reference value of the residual stress about the light guide plate which it curves [ light guide plate ] and does not produce deformation etc. after fabrication.

[0008]

[Means for Solving the Problem] The light guide plate of this invention which solves the above-mentioned technical problem is characterized by the stress in the surface portion of two principal planes which counter being two or less 200 kg/cm. In this light guide plate, each stress in the surface portion of two principal planes which counter is two or less 200 kg/cm, and it is desirable that the stress difference of the two principal planes concerned is less than 20%. Here, "principal planes" is two fields which is equivalent to the outgoing radiation side of a beam of light, and its rear face among the fields which constitute a light guide plate, which has a big area and which counter. The stress in the surface portion of a principal plane is measured by the method according to the method or this which shows in the below-mentioned example.

[0009]

[Embodiments of the Invention] The light guide plate of this invention is manufactured by the injection-molding method etc. Performing annealing processing (after treatment) etc. is mentioned to the light guide plate manufactured by the usual injection-molding method for manufacturing a light guide plate by the injection-compression-molding method manufacture a light guide plate by the injection-molding method by low-pressure molding which makes a filling pressure small as a means which makes stress in the surface portion of a light guide plate two or less [ 200kg //cm ]. If the synthetic resin used with injection molding is transparent thermoplastics, there will be especially no limit, for example, a polymethylmethacrylate, a polycarbonate, polystyrene, thermoplastic elastomer, or these copolymers will be mentioned. Moreover, the ratio (board thickness by the side of the board thickness / thin meat by the side of heavy-gage) of the board thickness by the side of [ which the light guide plate of this invention may have the taper-like configuration, and receives the board thickness by the side of thin meat in that case ] heavy-gage is usually 1.5 or more. Generally the aspect ratio of a light guide plate is about 4/3 in the ratio (length/width) of the vertical size and form width in a busy condition.

[0010]

[Example] Hereafter, an example explains this invention in detail. In addition, the equipment with which was manufacturing the light guide plate of an example by the injection-molding method, and manufacture was presented is as follows.

[0011] (b) information-separator[ by injection-molding-machine Toshiba Machine Co., Ltd. ]-350GS was used.

[0012] (b) metal mold -- metal mold -- three kinds -- using it -- \*\*\*\* -- each -- the size of metal mold etc. is as follows (Metal mold No. 1) It is 270mm in vertical size [ of 200mm ] x form width, and has the plate-like cavity whose board thickness is 2.0mm. The gate section of the size whose thickness width of face is 1.8mm in 25mm is prepared in the center of the horizontal side at this metal mold so that the configuration of a light guide plate where this metal mold was used and manufactured to drawing 2 may be shown. In addition, cutting processing of the gate section of a light guide plate is carried out with a heat nipper or a serrated knife.

(Metal mold No. 2) It is 270mm in vertical size [ of 200mm ] x form width, and board thickness has 2.0mm at the maximum, and has the cavity of the shape of a 0.8mm taper by the minimum. The gate section of the size whose thickness width of face is 1.8mm in 25mm is prepared in the position of 30mm from the heavy-gage side edge side of \*\*\*\* at this metal mold so that the light guide plate of the thickness deviation configuration where this metal mold was used and manufactured to drawing 3 may be shown.

(Metal mold No. 3) It is 290mm in vertical size [ of 210mm ] x form width, and board thickness has 2.0mm at the maximum, and has the cavity of the shape of a 0.8mm taper by the minimum. The gate section of the size whose thickness width of face is 1.8mm in 25mm is prepared in the position of 30mm from the heavy-gage side edge side of \*\*\*\* at this metal mold so that the light guide plate of the thickness deviation configuration where this metal mold was used and manufactured to drawing 4 may be shown.

[0013] (c) Parapet GH-1000S by Kuraray Co., Ltd. which are a molding-material methacrylic resin molding material were used.

[0014] (d) Measuring method low of the stress of the surface portion of mold goods speed Using saw (product made from BYURA : ISOMET), the strip of paper whose width of face is about 0.6mm was cut down from each portion within a mold-goods side, and the test piece with a mirror plane was obtained by grinding both cutting planes using the sandpaper of No. 2000, and a metal abrasive material. About the obtained test piece, the distorted retardation R was

measured on conditions 5 times the scale factor of this using Na light source by the BABINE amendment machine type precision stress meter (product made from Toshiba Glass : SVP- 30 II), and stress was computed by the following formula.

$$\text{Distortion (stress)} = R / (3.8 \times T)$$

(However, R is retardation and T is the thickness (cm) of the test piece of a retardation test section.) In addition, it is the opto elastic constant (nm/cm) ((kg/cm<sup>2</sup>)) of a polymethylmethacrylate in 3.8.

[0015] (e) As shown in measuring method drawing 5 (a) of deformation, and (b), the measuring point of the deformation of a light guide plate 5 is each corner section and the core of mold goods. Specifically, the light guide plate 5 was put on the surface plate 6, the crevice L between a surface plate 6 and a light guide plate 5 was measured with the SHIKUNESU gage, and the error of the configuration of metal mold and the configuration of a light guide plate was searched for.

[0016] (\*\*) constant temperature -- the reliability trial of a constant humidity examination light guide plate -- the constant temperature made from TABAI -- it carried out using the constant humidity chamber A test condition is 300 hours in 50-degree-C80%RH which is the standard evaluation method of a liquid crystal display.

[0017] (Examples 1-3 and examples 1-3 of comparison) The light guide plate was manufactured using the injection molding machine of a (b), and the metal mold of a (b), and the stress of the surface section of the obtained light guide plate was measured by the measuring method of a (d). then, the constant temperature of a (\*\*) -- the light guide plate was left by the environment of 50-degree-C80%RH with the constant humidity chamber, and the deformation after 300-hour progress was measured by the measuring method of a (e) The result is shown in Table 1. Measuring-point A-D is four corners of a light guide plate, and the measuring point E of the measuring point of the stress shown in Table 1 and deformation is a center position (refer to drawing 5 ). The same is said of Table 2 which back-\*\*. .

[0018]

[Table 1]

	金型の種類	表層部の応力 (kg/cm <sup>2</sup> )		試験前の 変形量 (mm)	試験後の 変形量 (mm)
		測定位置	応力		
実施例 1	No. 1	A	130	0.00	0.21
		B	115	0.03	0.17
		C	80	0.00	0.00
		D	96	0.00	0.03
		E	104	—	—
実施例 2	No. 2	A	165	0.00	0.30
		B	140	0.03	0.32
		C	102	0.03	0.00
		D	123	0.03	0.03
		E	125	—	—
実施例 3	No. 3	A	185	0.03	0.33
		B	160	0.03	0.35
		C	122	0.04	0.10
		D	130	0.03	0.13
		E	145	—	—
比較例 1	No. 1	A	220	0.03	2.50
		B	236	0.03	2.11
		C	200	0.04	2.30
		D	236	0.05	2.50
		E	235	—	—
比較例 2	No. 2	A	250	0.13	5.25
		B	243	0.08	5.17
		C	210	0.08	2.83
		D	226	0.09	3.54
		E	215	—	—
比較例 3	No. 3	A	275	0.13	6.50
		B	243	0.18	6.11
		C	221	0.13	3.30
		D	239	0.12	3.50
		E	221	—	—

[0019] the light guide plate of the examples 1-3 whose stress of the surface section is two or less 200 kg/cm as shown in Table 1 -- constant temperature -- the light guide plate of the examples 1-3 of comparison with which the stress of the surface section exceeds kg [ of 2 / 200 / / ] cm to a thing with the small deformation after a highly humid examination -- constant temperature -- the deformation after a highly humid examination is large The light guide plate of these

examples 1-3 had small deformation also in each examination of a 100 cycle \*\*\*\*\* examination in leaving it by turns under the examination dried at \*\*70 degree C for 300 hours, the examination left at \*\*-20 degree C for 300 hours, \*\*-20 degree C low temperature, and the elevated temperature of 70 degrees C.

[0020] (Examples 4-9) Like examples 1-3, using the injection molding machine of a (b), and the metal mold of a (b), the process condition was changed and the light guide plate was manufactured. The stress of the surface section of the obtained light guide plate was measured by the measuring method of a (d). then, the constant temperature of a (\*\*) -- the light guide plate was left by the environment of 50-degree-C80%RH with the constant humidity chamber, and the deformation after 300-hour progress was measured by the measuring method of a (e) The result is shown in Table 2.

[0021]

[Table 2]

	金型の種類	表面部の応力 (kg/cm <sup>2</sup> )			試験前の 変形量 (mm)	試験後の 変形量 (mm)
		測定位置	応力 (固定側)	応力 (固定側)		
実施例 4	No. 1	A	123	148	0.00	0.21
		B	126	115	0.03	0.17
		C	88	88	0.00	0.00
		D	102	950	0.00	0.03
		E	114	118	—	—
実施例 5	No. 2	A	165	180	0.00	0.30
		B	140	155	0.03	0.32
		C	102	113	0.00	0.00
		D	123	134	0.00	0.03
		E	125	120	—	—
実施例 6	No. 3	A	185	160	0.00	0.33
		B	160	145	0.03	0.35
		C	122	104	0.00	0.10
		D	130	137	0.00	0.13
		E	145	155	—	—
実施例 7	No. 1	A	110	152	0.00	2.21
		B	125	163	0.03	1.17
		C	100	126	0.00	1.87
		D	90	136	0.00	1.69
		E	114	138	—	—
実施例 8	No. 2	A	185	150	0.30	3.45
		B	170	130	0.23	3.86
		C	120	91	0.15	1.38
		D	137	100	0.24	1.71
		E	146	112	—	—
実施例 9	No. 3	A	196	152	0.35	3.75
		B	170	123	0.33	4.16
		C	110	85	0.21	2.18
		D	125	90	0.32	2.11
		E	148	113	—	—

[0022] the light guide plate of the examples 4-6 whose stress differences of a front face and a rear face the stress of the surface section is 20% or less or less [ 200kg //cm ] in two as shown in Table 2 -- constant temperature -- the examples 7-9 in which the stress difference of a front face and a rear face exceeds / the stress of the surface section / 20% by two or less 200 kg/cm to a thing with the very small deformation after a constant humidity examination -- constant temperature -- the deformation after a constant humidity examination was large a little

[0023]

[Effect of the Invention] Big curvature, deformation, etc. do not produce after fabrication the light guide plate which suits the reference value of this invention about the residual stress of a surface portion.

[Translation done.]

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CLAIMS

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[Claim(s)]

[Claim 1] The light guide plate characterized by the stress in the surface portion of two principal planes which counter being two or less 200 kg/cm.

[Claim 2] The light guide plate according to claim 1 whose stress difference of the two principal planes concerned each stress in the surface portion of two principal planes which counter is two or less 200 kg/cm, and is less than 20%.

[Claim 3] The light guide plate according to claim 1 or 2 manufactured by the injection-molding method.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the composition of the lighting system using the light guide plate.

[Drawing 2] the metal mold used in the example -- it is drawing showing the configuration of the mold goods by No.1

[Drawing 3] the metal mold used in the example -- it is drawing showing the configuration of the mold goods by No.2

[Drawing 4] the metal mold used in the example -- it is drawing showing the configuration of the mold goods by No.3

[Drawing 5] It is drawing for explaining the measuring point and measuring method of deformation of a light guide plate.

[Description of Notations]

1 : Light Source

2 : Light Guide Plate

2a: The incidence end face of a light guide plate

3 : Diffusion Sheet

4 : Reflective Sheet

5 : Light Guide Plate

6 : Surface Plate

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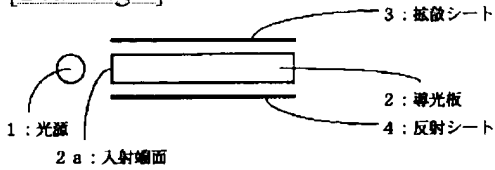
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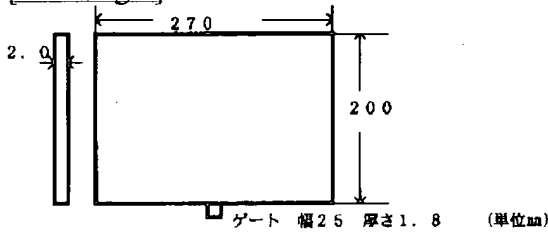
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## DRAWINGS

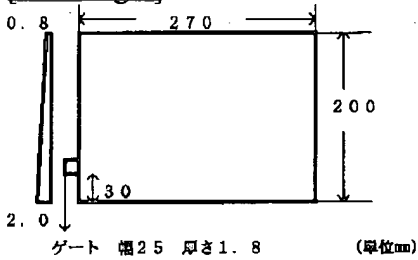
[Drawing 1]



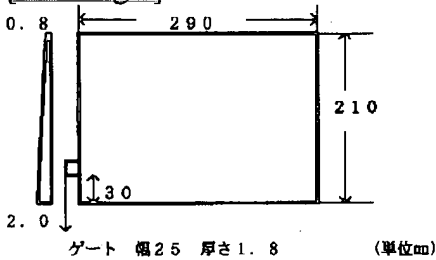
[Drawing 2]



[Drawing 3]



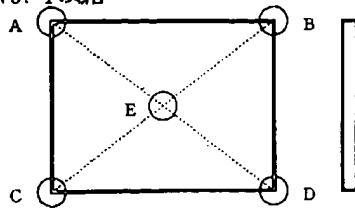
[Drawing 4]



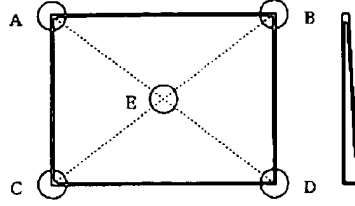
[Drawing 5]

## (a) 変形後の固定位置

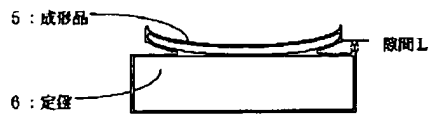
金型No. 1の場合



金型No. 2, 3の場合



## (b) 固定方法



[Translation done.]